EPSS Power Supply System Consortium Progress To Date
August 19, 1998

The Power Supply System Consortium was formed in April of 1998 at the EPSS Consortium Workshop held at Wright Patterson Air Force Base. This document is a compendium of documents which describe what has been discussed at each of the consortium meetings or workshops.

Consortium Workshop held in April 1998 at WPAFB – Initial Meeting GOTO Minutes

- ✓ Consortium Mission Statement Derived
- ✓ Consortium Action Plan Established
- ✓ Brainstorming Results – "What inhibits the extensive use of commercial resources?"

Potential Solutions to the problems which inhibit the use of commercial resources

- ✓ Table of Contents to the COTS Conference 1998 Proceedings
- ✓ Correlation of Consortium Workshop "problems which inhibit the use of commercial resources" to potential solutions as outlined in COTS Conference 1998

Second Consortium Workshop held in July 1998 at the NAECON conference in Dayton, OH GOTO Minutes

- ✓ Decided to focus on building codes for interfaces only
- ✓ Proposed set of building code categories (electrical, mechanical, environment, and system effectiveness)
- ✓ Decided to Initially focus on electrical interfaces
- ✓ Defined external electrical interface parameters which building codes may govern
- ✓ Comparison of Advanced Avionic, Telecommunication, and Medical electronic rack power supply system architectures
- ✓ Categorization of external electrical interface parameters

EPSS Consortium Workshop
Minutes
15, 16 April 1998
WPAFB

Prepared by Sergio Navarro

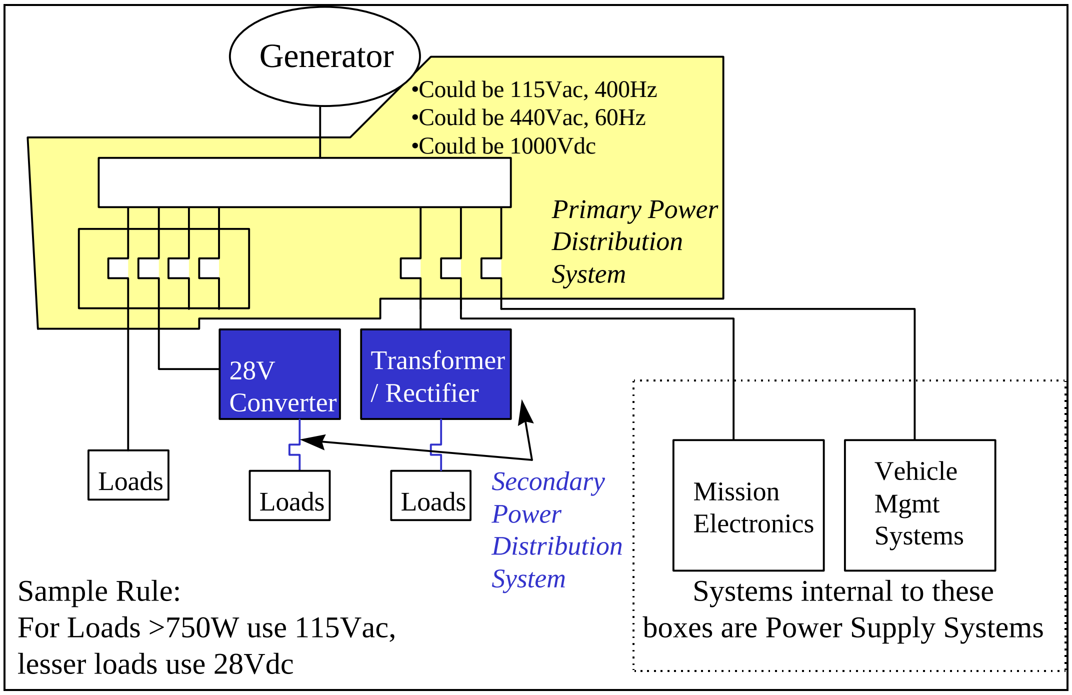
Introduction

The EPSS consortium workshop was held in Bldg 620 at WPAFB in Dayton Ohio from 9am to 5pm on 15 April 1998 and 8am to 4pm on 16 April 1998. After opening remarks from Mr. Marvin Soraya and Lt Col Glen Logan, Mr. Sergio Navarro provided some background information by way of an informal presentation. The General Discussion section captures the main topics discussed during this portion of the workshop. The remainder of the time was spent brainstorming and developing problems areas, impediments to solving the stated problems, consortium objective(s), consortium tasks, and consortium task flow. It was also decided that the government would draft a letter requesting that each of the participating companies continue to support the EPSS Consortium Activities. A total of 20 people participated in the workshop and are listed in the Attendee section. In an effort to capture what was actually said and discussed during the workshop "clarifications" of the discussion was kept to a minimum; this leads to some potentially unclear statements. Please review these minutes and feedback any clarifications.

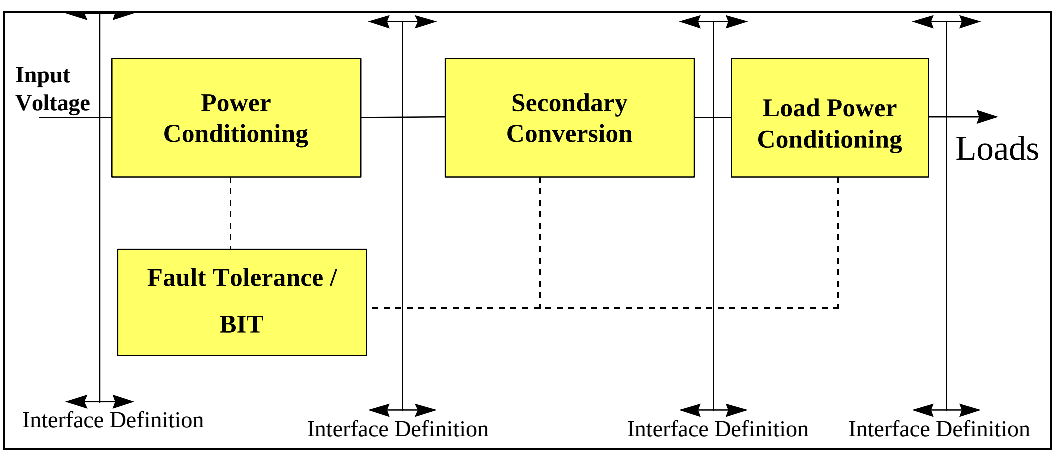
General Discussion

1. Focusing on "Avionics" (connotation meaning things that fly) is not a good approach for achieving affordability goals. We should focus on "rack" level entities, and allow these racks to be used where ever needed. Challenge is that there may well be different missions that these racks may have to live within; different missions have different driving requirements. For example, Space, shipboard, fighters, transports, ground mobile, etc.
2. Lets think of avionics in terms of RF electronics, processor electronics,. Sensor electronics… then of these in terms of high power, low power, static, pulsed, high voltage, low voltage, etc. to really derive practical rules or building codes. RETURN

1. There was a discussion relative to primary power distribution, secondary distribution, and a power supply system. The model that was developed is shown in the figure below:



2. The focus of the Consortium should be on providing power for Electronic Functions.
1. Focus on interfaces so that technology evolution has minimum impact: we agreed on which interfaces would need to be defined. They are shown in the figure below. For the "Load Power Conditioning" to Load interface it was decided that future trends needed to be understood and estimated to derive a long lived standard. It was agreed that this would be a "hard" undertaking, but that it should be



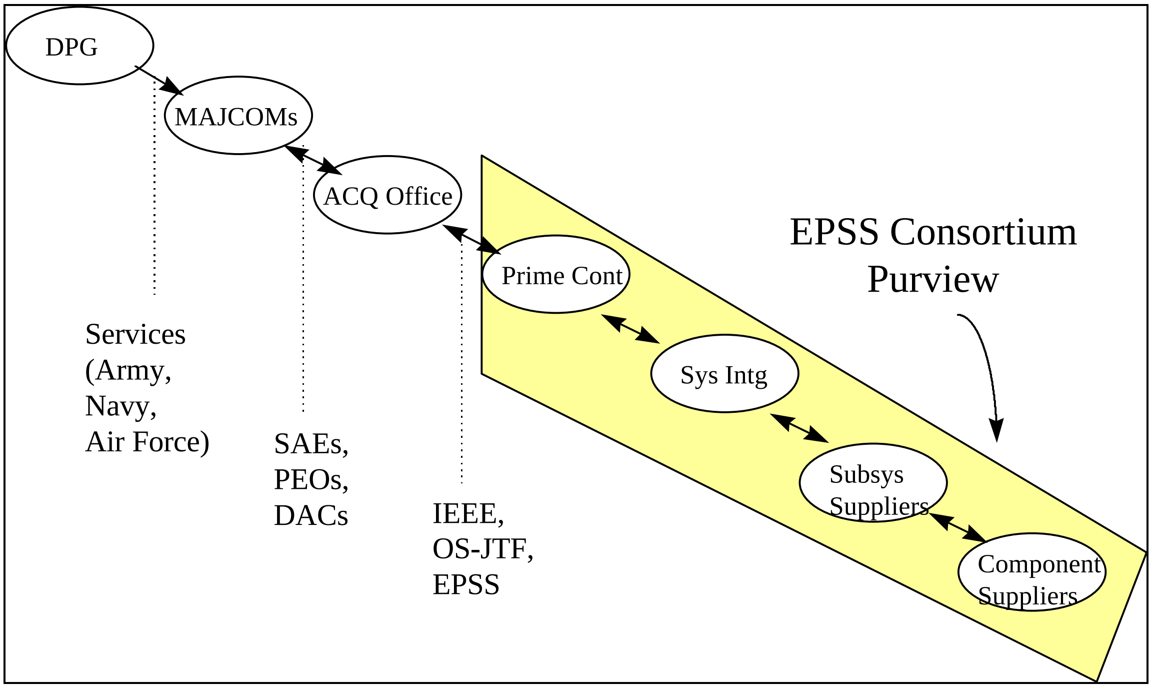
attempted.

2. The applicability of the standards to be developed was discussed. It was stated that the applicability needed to be new weapon systems and modifications to legacy weapon systems. The legacy systems having the largest leverage.
3. It was stated that we "can't afford NOT to use commercial resources."

4. It was stated that it is not necessary to use “commercial power supplies” to achieve our goal (more affordable power supply systems). The usage of commercial piece parts, commercial manufacturing / design services, etc. could provide sufficient savings.
5. A discussion relating to relative costs also occurred. The results are summarized in the table below

Cost Type	Low Volume	High Volume (>3000)
Relative Non-Recurring	90 to 75%	10%
Relative Recurring	10 -25%	90%
Total percent cost of power supply system relative to overall product cost: 10%		

10. Lt Col Logan identified his view (shown in the figure below) of the consoritum purview.



Consortium Problem Brainstorming Results RETURN

It was agreed that the list below does reflect what is keeping "us" from achieving more affordable or cost effective power supply systems. It was stated that many of the problems listed below are applicable to electronic products in general.

The listed problems are from a military contractor's perspective—commercial industry feedback is still required

These are problems related to leveraging commercial resources.

Problem Categories	Problems:
A. Lack/level of Testing	• (Commercil industry) degree of testing & qualification for modules (TEMP, Shock, Vib, EMC - 461, 704 is different. For example, FCC class A/B (support CE - but no CS?) • Industry vendors don't qualify parts to military needs.
B. Lack of Reliability, Maintainability, Supportability, Interchangeability Confidence	• Quality of discrete components (military vs Commercial/Industry), and difference in (approved) vendors (products who supposedly) make the "same" component. • No derating stds for commercial - (profit not derating driven-less conservative.)

Problem Categories	Problems:
B. Lack of Reliability, Maintainability, Supportability, Interchangeability Confidence	• MTBF Calculation (mil vs. Commercial/Industry) environments (are different). • Parts list info not generally available - vendor won't calculate MTBF. • No configuration control (vendors don't tell you when changes are made and provide no data to verify change impacts. • Durability of commercial/Industrial modules, discretes, etc (is not sufficient)--less design life (than military design). • Maintenance criteria - monitoring for repair to very low levels - too much BIT. • Commercial parts are not interchangeable - even if same mechanical footprint. • Material and process application used in Industrial products (are not compatible with military environment). • Using commercial Parts by "upscreening" due to contract requirements may not be cost effective. • ESD Issue - (commercial industry does not have sufficient controls).
C. Lack of Configuration Management	• Traceability of parts to assembly/component (not available in commercial industry).
D. Documentation	• Military industry needs to accept less documentation • Commercial vendor product characterization and advocacy (is insufficient).
E. Insufficient/Questionable performance Electrical, Mechanical and Environmental.	• Don't meet full input voltage range - 704E • No - "No Load" regulation requirements • Wider TEMP range (Mil vs commercial/industrial) • Design to environment is different between military and industrial - (salt spray, temp shock, jet fuel, …). • Weapon system designers need to agree to accept bigger/heavier elements. • Military has to accept less reliability. • Military contractors need to compromise certain requirements (temp, vibration…) • Military has more stringent packaging constraints - driven by installation requirements • Military has more stringent thermal mgmt constraints. • Commercial output regulation not good enough….to meet military electrical requirements. • EMC & efficiency not addressed (by

Problem Categories	Problems:
E. Insufficient/Questionable performance Electrical, Mechanical and Environmental.	commercial/industrial vendors). • Do products do what they want - (commercial vendors sell what they have). • Military needs too many load voltages - need custom power supplies. • Not optimum use of COTS modules (discrete power levels (10,20,50,100….) - leads to unacceptable designs.
F. Lack of Data Sharing	• Use of commercial resources results in lack of information to determine stability of the power supply system. - power supply vendor should be able to tell you if their product will be stable in “your” environment. (Military customer is not sure what he is getting). • Commercial vendors don’t provide product line metrics (yields and test steps) or process metrics, or field failure data. • Commercial vendors don’t share development of test data of products or cooling (thermal mgmt data).
G. Business Practices	• Warranty issue - will commercial vendors do this. Unique gov’t driven (FAR’s) environmental (OSHA, EPA, …) rules. • Military business is small compared to big commercial industries - commercial industry doesn’t want to adapt to military needs). • Suspect industrial vendor creditability/experience, learning curve, and ability to line up to commitment made. • Procurement to a vendor specification - provides a risk element because “you’re” at the whim of vendor. (“subject to change”) • “Across companies” configuration control - for modules, etc. • Commercial vendors don’t give priority to military.

Consortium Impediments Brainstorming Results

The listed impediments or hurdles are from a military contractor's perspective—commercial industry feedback is still required

These are impediments or hurdles to solving the problems.

Problem Categories	Impediments:
A. Lack/Level of Testing	1. Level of responsibility that vendor wants to take - he only wants to live up to what's in the data sheet - hence, he keeps to minimum. 2. Insufficient time to establish vendor creditability (for component, product…) - tight program schedules. 3. Vague contract language - internal company debates (e.g. component engr vs. Design engr). 4. Gov't stds at a higher level than industry stds or don't exist in industry stds. 5. Lack of test stds./consistency in test stds 6. Program to program and "customer to customer" standard test methods. 7. Each vendor has an established test method. 8. Military power supply system guys are small customers to industry vendors. 9. Parameters specified as "typical". - not minimum or maximum. 10. Unwillingness of vendor to sign up to "your" SCD. 11. Building block perspective: Military contractor needs to perform test/analysis to validate the product and needs to add peripheral components to meet system design reqmts. 12. Vendors won't guarantee their product. (main diff. between commercial product and military product is the amount of testing - which is not necessarily the same).
B. Lack of Reliability, Maintainability, Supportability, Interchangeability Confidence	1. Design inadequacy over the military environment - a potential solution is to strengthen the enclosure. ("Vital" Program type solution might be good) 2. Don't know which industrial power supplies could or do meet the military environment. 3. Uncomfortable using commercially "proven" parts - risk acceptance issue. 4. Issue of profit driven design creep to reduce cost - may result in negative design and/or performance impact. 5. Assumption that industry parts are not as reliable and maintainable - may not be the case.

Problem Categories	Impediments:
	6. No “ISO” type guidance across the industry - need stds for compliance. (might want to use DESC)
C. Lack of Configuration Mgmt (Coordination)	1. Don’t know when a commercial/industrial vendor will change something - not obligated to tell you. 2. They just sell a “black box” - very little data. 3. Need re-assurance that the military can track down where a problem exists. 4. Some companies still do business “the old way”. 5. Don’t have vendors who will provide military industry the type of coordination needed - might want to identify vendors who cater more to how the military wishes to do business…Identify niche market players.
D. Documentation	1. Military contractors need a minimum set documentation - don’t think commercial vendors provide this. - Provides “typical”. (Military contractor many times need to go to vendors anyway for data even when using mil-specs. 2. Can’t reconcile dearth of commercial vendor data vs. mountain of military required data.
E. Insufficient/Questionable Performance	1. Commercial data sheets don’t have sufficient data - lack information to perform product verification. 2. Don’t understand how to “use” the parts that are internal to commercial product; or how to use the commercial product correctly. 3. Military requirements are too stringent, or specify items that don’t need to be specified (Example - F-16 704A requirement - although power is cleaner). 4. Assumption is that industrial part can’t meet reqmt because wasn’t designed for that application. 5. Need to invest money to solve traditional (reg, …) performance short falls. 6. Commercial/Industrial vendors not interested in solving military performance problems. 7. External contracts/Internal derived requirement flow down (hinders use of commercial resources) 8. Need to design around “commercial” product performance; this implies additional volume will be required.

Problem Categories	Impediments:
F. Lack of data sharing - (This results in the inability to perform sufficient analysis).	1. Commercial vendors claiming that data is proprietary. 2. Vendors not willing to give “you” the data. 3. Vendors don’t create and/or provide the data. 4. Power supply community is very fragmented - “can be garage type operation”. 5. Commercial vendors are trying to make a buck - they try to get/maintain competitive edge.
G. Business Practices	1. Military power supply makret is a small part of the power supply industry - “mlitary market is small potatoes”. 2. Convincing people internally, meaning within a contractor organization, that “commercial” resources can be used. People have change their paradigm. 3. Lack of confidence in suppliers - “here today - gone tomorrow”. 4. Encumbrances that government puts contracts - OSHA, SDB, periodic re-competition, etc. 5. Not any real past performance data - if going to new commercial vendor - (this results in a negative to using commercial resources.)

Consortium Objective Statement, Tasks, and Task Flow RETURN

Consortium is defined as a group of people with a common interest.

Consortium Objective / Mission Statement

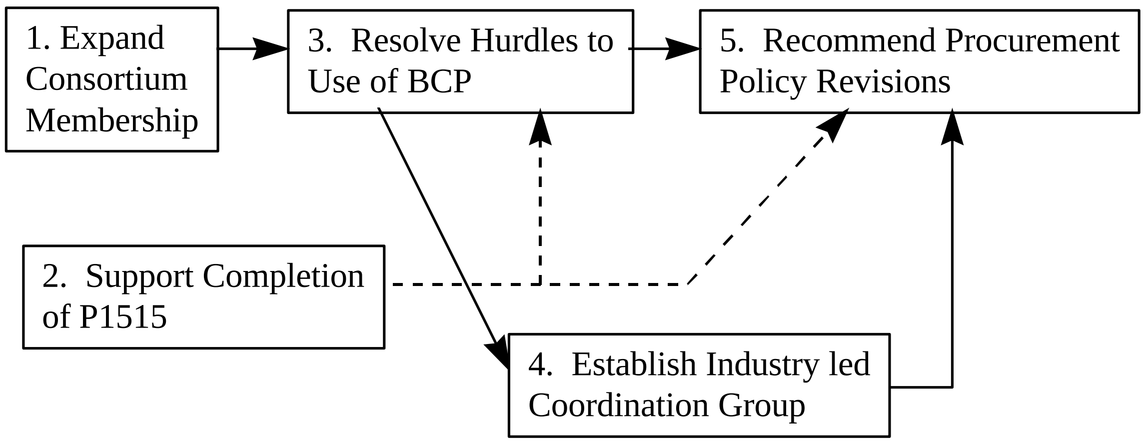
Facilitate the identification and resolution of technical and business case issues necessary to better harmonize the efforts of commercial and government power supply developers, manufacturers, integrators, and users.

Consortium Tasks

1. Expand Consortium membership:
   - Commercial, Telecommunication, and Industrial power supply vendors (Large, medium, and small)
   - Actively involve DoD (AF, Army, Navy, Marines, NASA)
   - Establish the EPSS Consortium as a recognized body
   - Involve Power Supply Manufacturers Association (PSMA)
2. Support the completion of IEEE P1515 Recommended Practice….Standard data sheet (s) can be developed using P1515
3. Determine (and resolve) the hurdles of using commercial / industrial items in military power (supply) systems
   - “Items” include practices, components, products, and processes
   - Evaluate the cost benefit

4. Establish an industry led coordination group for the development and maintenance of "power supply system" defacto building codes
5. Develop a set of recommendations to DoD to modify procurement policies affecting power supplies to make it possible to use more commercial resources…..resultant may be that the modified procurement policies will have applicability to more than just power supplies.

<u>Consortium Task Flow</u>



List of Represented Domains

Domains represented at the EPSS Consortium Workshop
• Boeing JSF/Boeing Power Supplies
• F-22/Commanche/Commercial Airline Power Supplies/Teledesic
• Smiths Industries, “Primary” Power distribution” - F-22, MADMEL, 777, Apache, VITAL
• Lockheed Martin-JSF (Avionics)
• Northrop Grumman - Integrate Avionics /F18/ATF
• Northrop Grumman - JSF/Long Bow/JSTARS/Space Based RADAR
• GEC - RF Mgr - JSF/F-22/Commanche/PMCS
• Raytheon - Airborne Radar/F-18, F-15/Dual use technology - power electronics
• Rocketdyne - Space Power - Space Station

List of Attendees RETURN

Name	Organization	Phone Number
Carlos Gonzalez	Raytheon Systems Co.	310-334-8375
Margarita T. Savoie	Boeing Co.	818-586-9425
Ishaque Mehdi	Boeing Co.	253-657-3104
Paul Curtis	Raytheon Systems Co	310-334-8389
Ron Burgess	Northrop Grumman	310-332-8258
Steve Layton	Smiths Industries	973-514-4054
Stuart Downs	TRW	619-592-3183
Ray Petit	Boeing Co.	206-655-2112
Rick Wild	LMTAS	817-763-3967
Anthony F. Laviano	Raytheon Systems Co.	310-334-7731
John Ostgaard	AFRL/IFS	937-255-4709 x 4182
Steve Payne	TRW / OS-JTF	703-578-6165
Charles Hurst	ISI / OS-JTF	937-256-9933
Glen Logan	OS-JTF	703-578-6584
Sergio Navarro	TRW	937-429-7993
Brian Carlson	GEC-Marconi	973-633-3431
Steve Benning	AFRL/IFSC	937-255-4709 x 4170
Ken Trumble	AFRL/IFSC	937-255-4854 x4157
Reed Morgan	AFRL/IFSC	937-255-4709 x4180
Brian Branthover	Northrop Grumman-ESSD	410-765-2257

COTScon '98

May 28 & 29, 1998

McLean Hilton at Tysons Corner • McLean, Virginia

TABLE OF CONTENTS

EPSS Consortium "7 Problem" Assessment RETURN
Potential Solutions Per COTS Conference 1998
[Working Draft]
07/13/98 10:50 AM

Problem Category A. Lack and Level of Testing

Problems	Impediments	Potential Solutions
• (Commercial industry) degree of testing & qualification for modules (TEMP, Shock, Vib, EMC - 461, 704 is different. For example, FCC class A/B (support CE - but no CS?) • Industry vendors don't qualify parts to military needs.	1. Level of responsibility that vendor wants to take - he only wants to live up to what's in the data sheet - hence, he keeps to minimum.	True, HAST testing is used in conjunction with analysis to get confidence in products. HAST = Highly Accelerated Stress Testing
	2. Insufficient time to establish vendor creditability (for component, product…) - tight program schedules.	
	3. Vague contract language - internal company debates (e.g. component engr s. Design engr).	
	4. Gov't stds at a higher level than industry stds or don't exist in industry stds.	In many cases this is true and trend will more than likely continue. When military drove the IC market, IC vendors designed for -60 to 130C; however, now due to market pressures the IC industry no longer designs to these extremes. Common IC design range is now -10 to 80C; making upscreening for military applications more risky. Designers must have excellent communication with IC vendors to insure acceptable parts.
	5. Lack of test stds./consistency in test stds	This was echoed in the conference. *P1515 is trying to address this issue.*
	6. Program to program and "customer to customer" standard test methods.	This was echoed in the conference. *P1515 is trying to address this issue.*
	7. Each vendor has an established test method.	This was echoed in the conference. *P1515 is trying to address this issue.*
	8. Military power supply system guys are small customers to industry vendors.	Agreed, Military has 9% of DC to DC power supply market share.

Problems	Impediments	Potential Solutions
	9. Parameters specified as “typical”. - not minimum or maximum.	
	10. Unwillingness of vendor to sign up to “your” SCD.	A trend which may well continue..... many companies which are utilizing COTS are adapting the environment to allow the used of COTS products.
	11. Building block perspective: Military contractor needs to perform test/analysis to validate the product and needs to add peripheral components to meet system design reqmts.	
	12. Vendors won’t guarantee their product. (main diff. between commercial product and military product is the amount of testing - which is not necessarily the same).	Vendors guarantee their product for their designed environment; military users must guarantee the performance for a military environment.

General Notes:

1) Acronym List

QML = Qualified Manufacturers Line
ESS = Environmental Stress Screeing
PEM = Plastic Encapsulated Microcircuit
HAST= Highly Accelerated Screening Test
HALT = Highly Accelerated Life Test
Piece Part Temperature Ranges: 0-70C commercial, -40 to 85C industrial, -55 to 125C military

2) Italics imply parenthetical statements

Problem Category B. Lack of Reliability, Maintainability, Supportability, Interchangeability Confidence

Problems	Impediments	Potential Solutions
• MTBF Calculation (mil vs. Commercial/Industry) environments (are different). • Parts list info not generally available - vendor won't calculate MTBF. • No configuration control (vendors don't tell you when changes are made and provide no data to verify change impacts. • Durability of commercial/Industrial modules, discretes, etc (is not sufficient)-- less design life (than military design). • Maintenance criteria - monitoring for repair to very low levels - too much BIT. • Commercial parts are not interchangeable - even if same mechanical footprint. • Material and process application used in Industrial products (are not compatible with military environment). • Using commercial Parts by "upscreening" due to contract requirements may not be cost effective. • ESD Issue - (commercial industry does not have sufficient controls).	1. Design inadequacy over the military environment - a potential solution is to strengthen the enclosure. ("Vital" Program type solution might be good)	Mentioned many time throughout the conference. Special enclosures are used to meet unique military environments (chemical, temperature, vibration, EMP, radiation, etc.)
	2. Don't know which industrial power supplies could or do meet the military environment.	Common solution was to establish good vendor relationships. *P1515 will help by developing a common specification language and enhance clear communication.*
	3. Uncomfortable using commercially "proven" parts - risk acceptance issue.	Its clear that DOD wants to use COTS; however, many working level groups - reliability, quality, logistics, etc. - are skeptical of the viability of using COTS. Many conference attendees believe that COTS piece parts are more reliable than traditional military parts especially QML parts.
	4. Issue of profit driven design creep to reduce cost - may result in negative design and/or performance impact.	Use of COTS requires a very good supplier interface. Changes are documented, but are not shared with customers unless the customers have specifically request the information ... must be a contract line item.
	5. Assumption that industry parts are not as reliable and maintainable - may not be the case.	Many commercial IC's are no longer designed for -55 to 125C operation; thus upscreening of IC's should only be used as a last resort. Typically, upscreening is the most expensive way to buy parts. Using QML parts is the best choice. Industrial grade piece parts are usually acceptable.
	6. No "ISO" type guidance across the industry - need stds for compliance. (might want to use DESC)	Solid state piece parts for Transportation and Automotive are per JEDEC Standard No. 22-B

Problems	Impediments	Potential Solutions
	Lack of Reliability, Maintainability, Supportability, Interchangeability Confidence	• HALT (Highly Accelerated Life Testing) is typically used to give confidence that upscreening will be OK. However, HALT testing does not yield a MTBF measure - just a good feel. Mil-HDBK-217 is very conservative....actual field MTBF's are higher. Bellcore predictions can be a factor of 10 greater than "-217". • Most piece parts(commercial, industrial, military) are all built on the same line. Hence, tests are really for categorization no upscreening. • For typical "box" temperature range of -40 to 70C industrial grade parts (-40 to 85C) can generally be used. • To successfully use COTS the application domain must be well understood. Typically, COTS product need to be adapted for military applications; in these situations it is best to tailor requirements to allow for multiple vendors. • Blanket commercial quality is a myth.... quality varies greatly between vendors. Few industry standards exist, and ISO-9000 does not guarantee quality. • Use of PEM's is good but caution needs to be exercised. Not all plastics are equal, and there must be cognizance of Tg and moisture absorption. • Reliability must be accomplished from the top down....the environment, redundancy possibilities, and health monitoring must be understood first. • University of Maryland (Calle - spelling?) is trying to predict commercial part life via physics of failure studies. From the outset designs need to be compatable with technology insertion with functionality maintained or improved during each upgrade.

Problems	Impediments	Potential Solutions

Problem Category C. Lack of Configuration Mgmt (Coordination)

Problems	Impediments	Potential Solutions
Traceability of parts to assembly/component (not available in commercial industry).	1. Don't know when a commercial/industrial vendor will change something - not obligated to tell you.	Commercial vendors document their changes, but don't share the data unless they are specifically requested. This type of request should be part of the contract. If the vendor won't balks at this type of request, it is best to find another vendor.
	2. They just sell a "black box" – very little data.	Commercial vendors need to be willing to work with military contractors to confirm that their design/product will operate in a military environment. Vendors will provide data for a price. Ultimate military product documentation and configuration is the responsibility of the military contractor.
	3. Need re-assurance that the military can track down where a problem exists.	Bottom line – Use of COTS reduces degree of "control". Consequently, a process needs to be developed to deal with this reality.
	4. Some companies still do business "the old way".	
	5. Don't have vendors who will provide military industry the type of coordination needed - might want to identify vendors who cater more to how the military wishes to do business…Identify niche market players.	This was inferred many times throughout the conference. DOD's Acquisition Reform efforts are attempting to reduce the requirements that drive configuration management costs associated with technology insertion.
		• Semi-conductor packages are starting to be standardized – once again • Passive parts don't have an equivalent "QML" , but DESC is in the process of trying to establish an equivalent type of system.

Problem Category D. **Documentation**

Problems	Impediments	Potential Solutions
• Military industry needs to accept less documentation • Commercial vendor product characterization and advocacy (is insufficient).	1. Military contractors need a minimum set documentation **-** don't think commercial vendors provide this. **-** Provides "typical". (Military contractors many times need to go to vendors anyway for data even when using mil-specs.	This type of data needs to be explicitly requested. Key is to establish a good working relationship with vendors, and work with them to establish what is needed to meet military needs in an affordable way.
	2. Can't reconcile dearth of commercial vendor data vs. mountain of military required data.	Plastic parts would cost as much as ceramic parts if Mil-stds were applied to them due to the documentation and test costs.

Problem Category E. **Insufficient/Questionable Performance**

Problems	Impediments	Potential Solutions
• Don't meet full input voltage range - 704E • No - "No Load" regulation requirements • Wider TEMP range (Mil vs commercial/industrial) • Design to environment is different between military and industrial - (salt spray, temp shock, jet fuel, …). • Weapon system designers need to agree to accept bigger/heavier elements. • Military has to accept less reliability. • Military contractors need to compromise certain requirements (temp, vibration…) • Military has more stringent packaging constraints - driven by installation requirements • Military has more stringent thermal mgmt constraints. • Commercial output regulation not good enough….to meet military electrical requirements. • EMC & efficiency not addressed (by commercial/industrial vendors).	1. Commercial data sheets don't have sufficient data - lack information to perform product verification.	Working with the vendor is key – product verification for a military environment can only be accomplished with the vendors support
	2. Don't understand how to "use" the parts that are internal to commercial product; or how to use the commercial product correctly.	• IC vendors many times have agreements with many foundries; hence, you don't always get the same die from a given manufacturer. • Key is to talk to vendors honestly – explain your problems, and listen to their "out of box" solutions.
	3. Military requirements are too stringent, or specify items that don't need to be specified (Example - F-16 704A requirement - although power is cleaner).	Conference attendees recognized this as an issue – DOD is wrestling with how to deal with this. Some weapon system contractors are doing this type of characterization for certain systems.
	4. Assumption is that industrial part *(product)* can't meet reqmt because wasn't designed for that application.	One approach has been to take a product line approach. That is, define a product that meets 80% of the core requirements, then tailor the remaining 20% for each unique customer.
	5. Need to invest money to solve traditional (reg, …) performance short falls.	
	6. Commercial/Industrial vendors not interested in solving military performance problems.	Depends on the vendor…. One theme was "trust but verify". Reference checks are a good method. Another theme was, " Don't throw away possibilities because you've never done it that way"
	7. External contracts/Internal derived requirement flow down (hinders use of commercial resources)	Military contractor is responsible for their own specifications – a process needs to be established that gives confidence that "your" specifications are what you need and they are consistent with COTS. *[Essentially at the crux of what P1515 and the Consortium activities are all about]*

Problems	Impediments	Potential Solutions
	8. Need to design around "commercial" product performance; this implies additional volume will be required.	• Common theme: End user has not reduced expectations; environments, reliability, size, weight, etc. still must meet military needs. • Recommended the use of HALT and HASS testing for units with commercial components to weed out latent failures.
Problem E: Insufficient/Questionable Performance		• COTS does not mean using a product outside of its stated specifications. • Government has not relaxed its imperatives of mission success. • No trend in reducing durability requirements… trend is probably in the direction of trying to increase durability • To successfully use COTS the ability to forecast commercial technology and standards is important, e.g., VHS versus Beta • Technical problems are surmountable – cultural problems are considerably tougher: Less control of configuration management and logistics, multiple concurrent configurations, O to OEM maintenance concept, etc. • Ruggedization / environmental control plan for military application is essential – key is to be creative

Problem Category F. **Lack of data sharing - (This results in the inability to perform sufficient analysis)**

Problems	Impediments	Potential Solutions
• Use of commercial resources results in lack of information to determine stability of the power supply system. - power supply vendor should be able to tell you if their product will be stable in “your” environment. (Military customer is not sure what he is getting). • Commercial vendors don’t provide product line metrics (yields and test steps) or process metrics, or field failure data. • Commercial vendors don’t share development of test data of products or cooling (thermal mgmt data).	1. Commercial vendors claiming that data are proprietary.	Vendors need to be chosen wisely. If vendors aren’t willing to share data, they should be considered high risk.
	2. Vendors not willing to give “you” the data.	Vendors need to be chosen wisely. If vendors aren’t willing to share data, they should be considered high risk.
	3. Vendors don’t create and/or provide the data.	Best solution is to have vendor and contractor work together on a solution. Vendors are the only ones that really know their product. Many times a standard product can be used with a military contractor providing what is necessary to work on the required enclosure or board.
	4. Power supply community is very fragmented - “can be garage type operation”.	
	5. Commercial vendors are trying to make a buck - they try to get/maintain competitive edge.	COTS game is a risk management game. A risk management plan needs to be established which includes vendor expectations and confidence testing.

Problem Category G. Business Practices

Problems	Impediments	Potential Solutions
• Warranty issue - will commercial vendors do this. • Unique gov't driven (FAR's) environmental (OSHA, EPA, …) rules. • Military business is small compared to big commercial industries - commercial industry doesn't want to adapt to military needs). • Suspect industrial vendor creditability/experience, learning curve, and ability to line up to commitment made. • Procurement to a vendor specification - provides a risk element because "you're" at the whim of vendor. ("subject to change") • "Across companies" configuration control - for modules, etc. • Commercial vendors don't give priority to military.	1. Military power supply market is a small part of the power supply industry - "military market is small potatoes".	Key is to identify vendors that want to work with you. *[PSMA may be helpful here]*
	2. Convincing people internally, meaning within a contractor organization, that "commercial" resources can be used. People have change their paradigm.	This is viewed as a tougher issue than the technical issues.
	3. Lack of confidence in suppliers - "here today - gone tomorrow".	A comprehensive Risk Assessment needs to be done before selecting COTS
	4. Encumbrances that government puts contracts - OSHA, SDB, periodic re-competition, etc.	DOD's Acquisition Reform activities are dealing with these issues.
	5. Not any real past performance data - if going to new commercial vendor - (this results in a negative to using commercial resources.)	
		• There is no unified DOD stance on PEMs (Plastic Encapsulated Microcircuit) reliability. DOD is laying this type of decision back on the contractors. • Configuration Management control must be planned for upfront.

EPSS Consortium Meeting Minutes RETURN

16 July 1998
at NAECON'98 Conference
Dayton, Ohio

Prepared by Sergio Navarro

Introduction

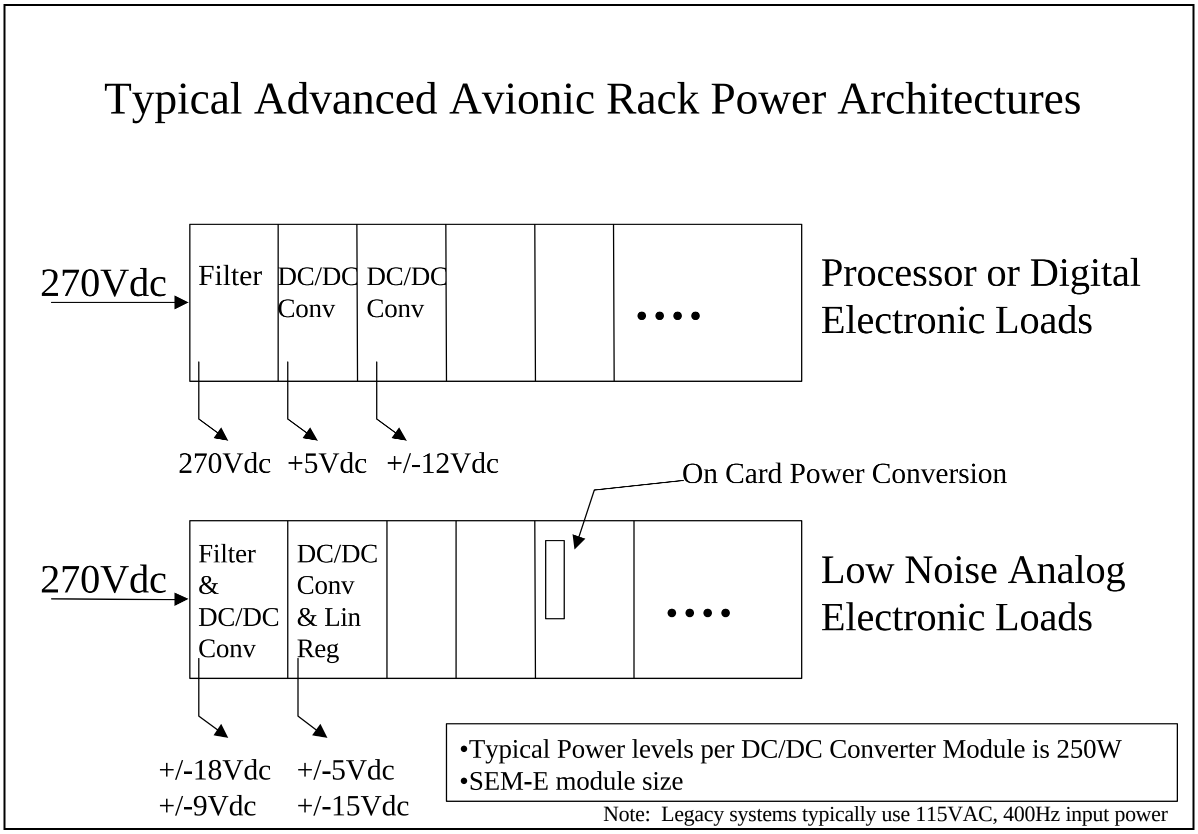
Mr. Sergio Navarro gave a brief overview of the Electronic Power Specification Standardization (EPSS) Consortium activity. Since this meeting was held subsequent to the IEEE P1515 meeting with the same participants, no further introductions of participants was needed. Consortium concepts were discussed and in the end well received. Intent of this consortium meeting was to brainstorm ideas and thoughts regarding consortium building codes / rules; discussion, results, and actions are summarized below. List of attendees is included in the last section of this document.

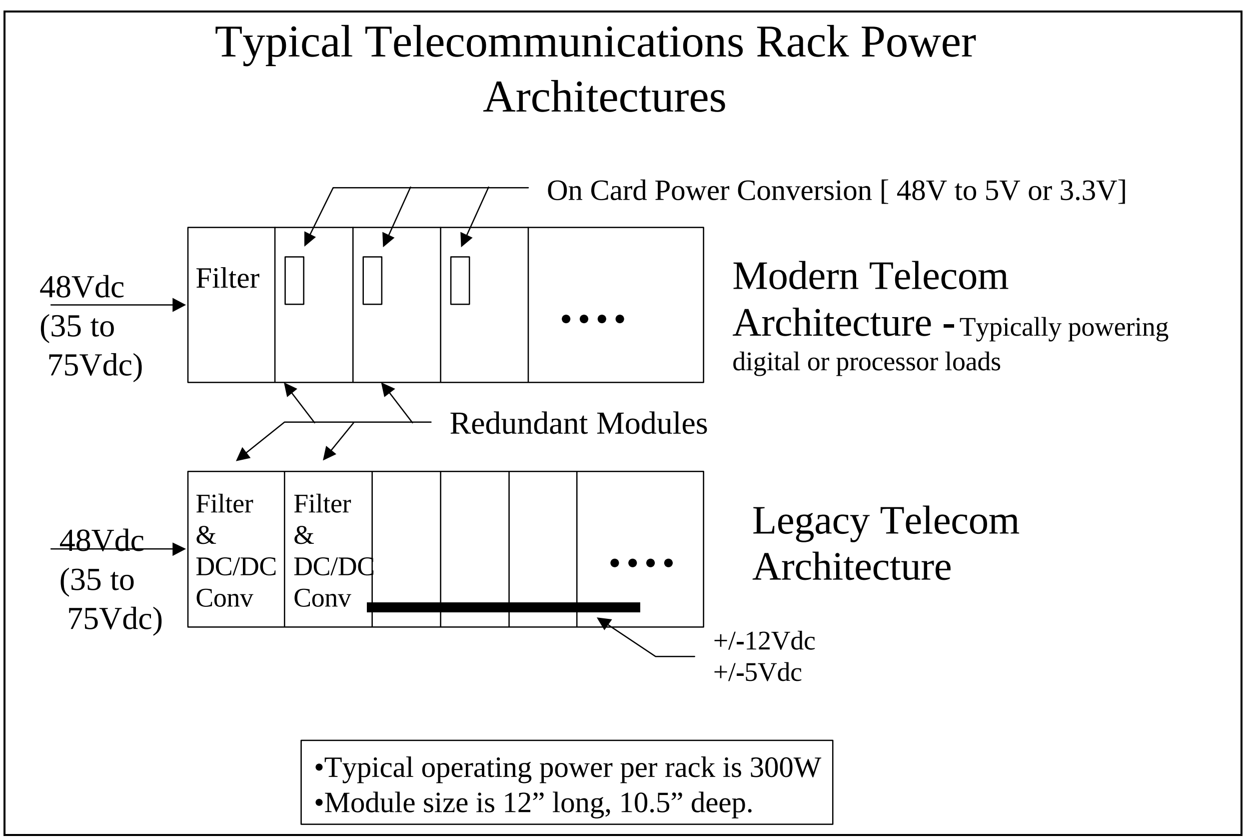
The boundary between P1515 specification language and EPSS consortium building codes / rules was discussed. The conclusion was essentially that the specification language is application independent; the language defines what a parameter is and how it is to be verified or tested without specific regard to application. The consortium's building codes/rules need to be application specific because they will guide the development of military power supply systems that highly leverage commercial resources. For example, these rules could define the acceptable temperature range of a commercial product, the minimum vibration level over a given spectrum, the minimum EMC performance, etc.

Key Discussions

1. It was noted that the P1515 specification language and consortium building codes are coupled; the specification language defines parameter and test conditions while the building codes define what specification is acceptable for a given application.
2. It was noted that the present thrust for consortium building codes is focused on "rack level electronics", and specifically on digital and low level analog electronics.
3. Building code emphasis must be at the interface level. Four interface categories were proposed 1) Electrical, 2) Mechanical, 3) Environmental, and 4) System Effectiveness
4. A proposal was made and accepted that the first interface category to be addressed needs to be the electrical interface. Rationale being that if this interface cannot be made compatible with commercial resources, then there would be no need to look further. All were in agreement that early success is mandatory, hence, focusing on a single category is necessary.
5. Commercial members understood the benefit that the consortium building codes/rules bring to DoD; they were unsure what benefit the commercial industry would be garnering. Commercial participants indicated that selling their products (As-Is) to the military would certainly be a benefit, and that selling a militarized version might be a benefit. From a product standpoint, it was believed that the military industry could use board mounted power supply modules As-Is. Since the telecommunications standard rack voltage is 48V, having a rule that indicates a rack input voltage of 48V could provide significant leverage.

6. Two rack level power supply architectures were presented: 1) Advanced military avionics , and 2) telecommunications. They are shown below.





7. The majority of the discussions focused on topics relevant to the use of commercial products for military power supply systems. However, it was pointed out that the intent is to be able to leverage commercial resources which encompass not only commercial products, but also commercial services, processes, and components. The participants acknowledged this, and professed the belief that the highest leverage commercial resource would be products; hence, the emphasis during this meeting.
8. A brainstorming session resulted in the definition of interface parameters which define the electrical interface to and from a power supply system. The parameters defined should be considered an initial listing which will be augmented as the consortium activity continues. The results of this brainstorming session are shown below in Item #4 in the "Results and Actions" section. It should be noted that building codes/rules were not defined, only the parameters which may be subject to building codes/rules were defined; at the next consortium session building codes/rules will be defined which will govern some of the defined interface parameters.
9. A discussion revolving around the difference between voltage ripple and EMI ensued. A suggested difference was given as follows:
   Voltage Ripple is noise which interrupts the operation of the power supplies load – of more local interest
   EMI is noise which interrupts the operation of the system – of more system interest. Existing standards typically address system level EMI issues.
   These two items are generally designed for concurrently because they are inter-related.

Results / Actions

1. To allow better understanding of the different type of power supply systems, actions were assigned to define the power supply system architectures in use today from the following fields:

Field	Action Responsibility
Medical	S. Navarro
Automotive	Harry Lamberth
Space	Craig Elder
Industrial Equipment[1]	Jeff Bledsoe
Shipboard	Harry Lamberth
EDP	Open
Avionics – Commercial	Ted Hoffman
Missiles	Open

2. Action Item: Sergio Navarro is to further categorize the parameters in item #3 below into 1) AC and DC parameters, and 2) into requirement parameters and design parameters. The difference between requirement and design parameters being that the requirement parameters are given to the designer while design parameters are derived by the designer in order to meet the requirement parameters. For example, load impedance is a requirement parameter, where as, power supply output impedance is a design parameter chosen to be compatible with a given range of load impedance.
3. Action Item: Sergio Navarro to update the "Power Supply System Electrical Interface" diagram shown below to correlate the various architectures to this interface diagram. For instance, the final diagram should show how the architectures derived in "Results and Actions" item #1 map to the "Power Supply System Electrical Interface" figure shown below.
4. Results of brainstorming – Power supply system interface parameter definitions
   First of all, the interfaces of interest were defined; these are shown in the figure below. Brainstorming focused on the external interfaces only, that is, interfaces to the source power and to the loads. It was suggested that the Pentium Chip power interface be reviewed; this interface is considered to be well thought out and complete.

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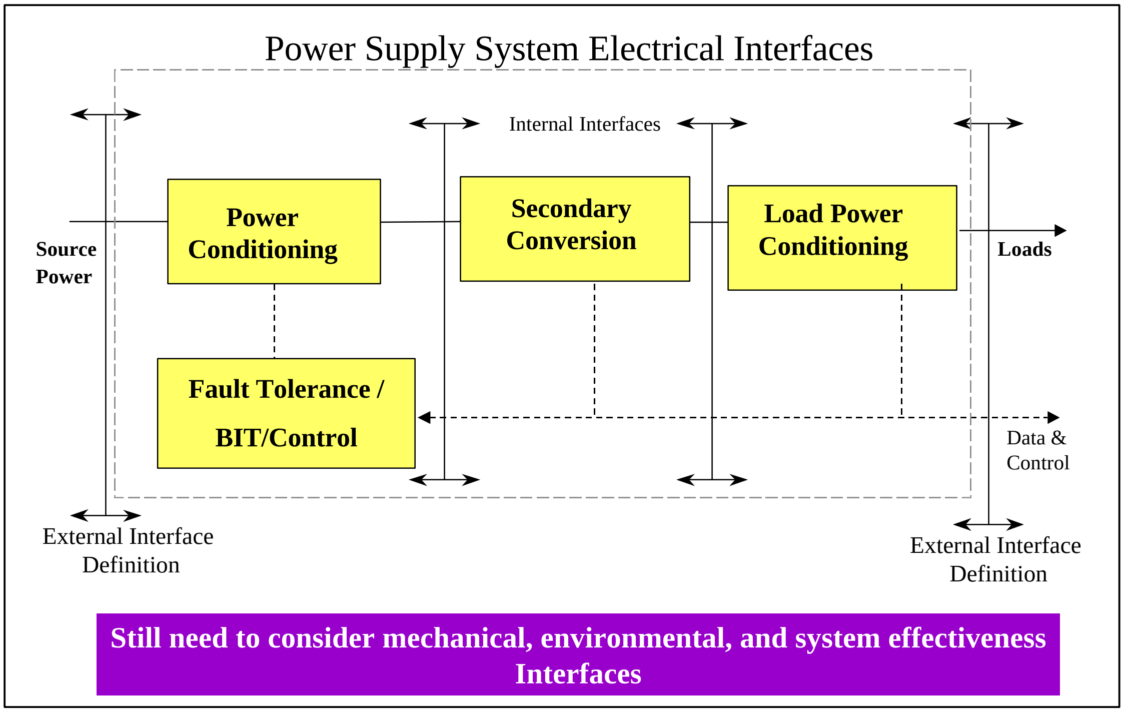
[1] Industrial equipment refers to robotic machines, process control systems, etc.



The **load interfaces** are shown below and categorized as "power" and "other" interfaces.

LOAD ELECTRICAL Interface Parameter	Category	LOAD ELECTRICAL Interface Parameter	Category
Output Voltage and Tolerance	A	Power Up Voltage Sequence, including Correct levels	A
Voltage Ripple	A	Shutdown Sequence	A
Output Impedance	A	Current Sharing – multiple modules….pin definitions	B
Load Impedance	A	Output voltage trim	B
Overvoltage tolerance and Protection Point	A	Max di/dt	A
Pin Current Capacity		Voltage Programming	B
(Pin outs)		Status Monitoring	B
Load Dynamics – step loads, etc.	A	Hold-up Time	A
Low Voltage Protection	A	Power Failure Interrupt	B
Overcurrent Trip point	A	Over-temperature failure command to power supply	B
Short Circuit Response	A	Overvoltage and Overcurrent characteristics	A
Output Voltage Remote Sense	B	Power on Reset	B
Load Current Range	A	ESD	
Start Up Trajectory – time domain	A		

Legend: A = Power, B=Other, Blank= Being Evaluated

The **<u>source interfaces</u>** are shown below with some categorized as “power” and “other” interfaces.

SOURCE ELECTRICAL Interface Parameter	**Category**	**SOURCE ELECTRICAL Interface Parameter**	**Category**
Output Voltage and Tolerance	A	Voltage Transients(spikes, sag, surge) characteristics	
Voltage Ripple	A	Power Interrupt	
Load Current Range	A	Max Fault Current	
Load Dynamics – step transients, etc.	A	Undervoltage Protection (shutdown & recovery characteristics)	
Overcurrent Trip point	A	Reverse Polarity Protection	
Max di/dt	A	3 Phase – Phase rotation insensitivity	
Status Monitoring	B	Source Impedance as a function of frequency	
EMI		Noise immunity – conducted susceptibility	
AC Power Factor (1399-Navy, 1540, 704,….) • Harmonic content – loss of 1 phase(single phasing) • Third Harmonic Distortion • 3 phase: I & V balance • Frequency		Multiple Input Fault Tolerance	
Isolation and grounding		Spike / Surge Protection	
Inrush Current		ESD	
Voltage spike (<< than 1 cycle)			
Leakage current to ground (AC)			

Legend: A = Power, B=Other, Blank= Being Evaluated

Next Meeting

Pre-INTELEC meeting to be held at Rockwell Collins, Cedar Rapids, IOWA. September 15, 16 1998.

INTELEC Meeting: During the INTELEC Conference for two days during 4 – 8 October 1998. Specific days are still being finalized.

List of Attendees RETURN

Name	Organization	Phone	email
Bledsoe, Jeff	Lockheed Martin TAS	817-777-7969	jeff.p.bledsoe@lmco.com
Branthover, Brian	Northrup Grumman	410-765-2257	john_b_branthover@mail.northgrum.com
Cooper, David	Nortel	613-763-2454	cooperd@nortel.com
Elder, Craig	TRW	310-813-5252	craig.elder@trw.com
Gonzalez, Carlos	RSC	310-334-8375	chgonzalez@west.raytheon.com
Harrington, Joe	USAF ASC/RAE	937-255-9767	harrinjp@rasg.wpafb.af.mil
Hoffman, Ted	Rockwell-Collins	319-295-3658	tjhoffman@collins.rockwell.com
Hurst, Charles R	ISI (OS-JTF)	937-256-9933	crhurst@aol.com
Lamberth, Harry	Power Paragon	714-956-9200, x134	hlamberth@powerparagon.com
Laviano, Anthony	RSC	310-334-7731	aflaviano@west.raytheon.com
Liu, Yan-Fei	Nortel	613-763-3937	liuyf@nortel.com
Logan, Lt Col Glen	OS-JTF	703-578-6584	logangt@acq.osd.mil
Mehdi, Ishaque S	Boeing ISDS	253-657-3104	ishaque.s.mehdi@boeing.com
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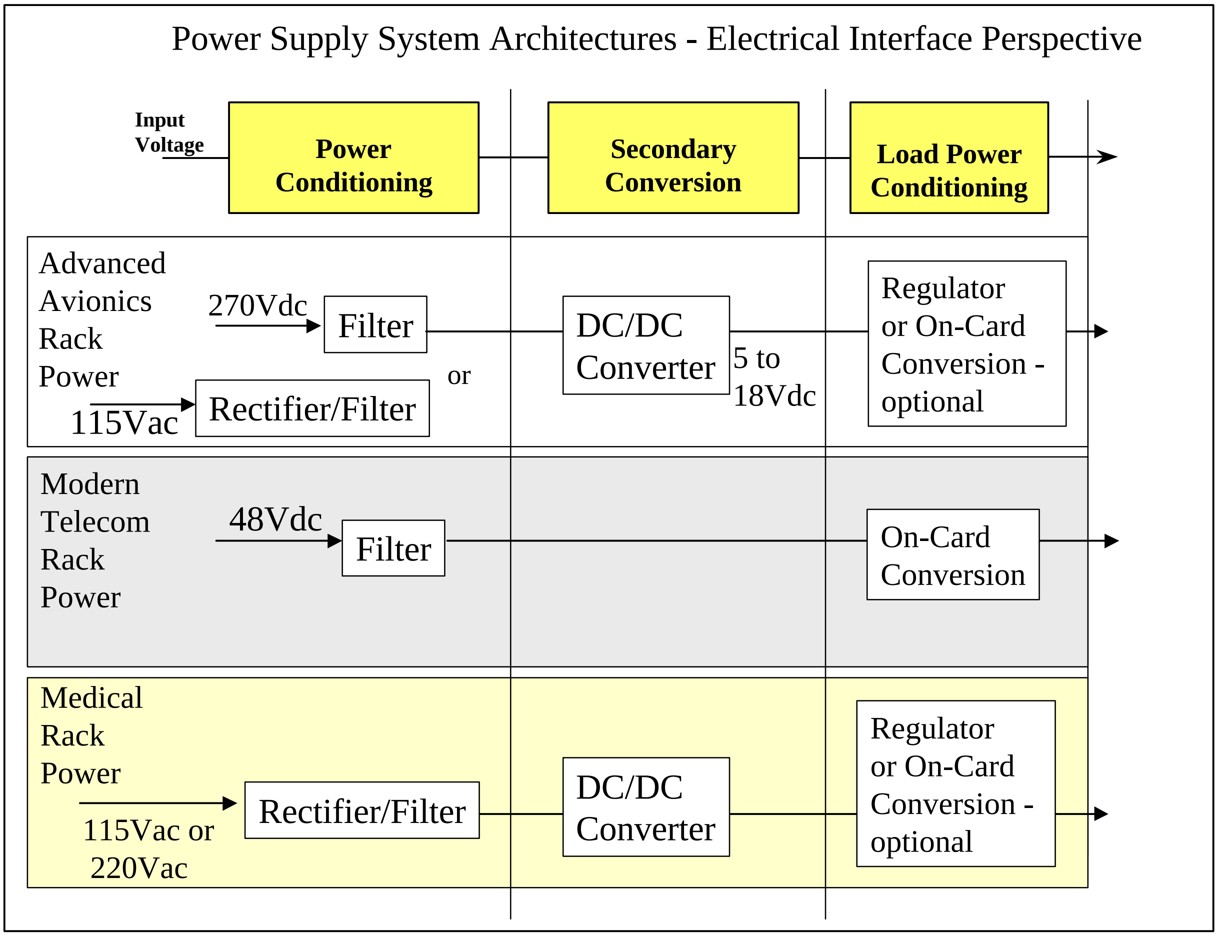
Payne, Steve	TRW	703-578-6165	paynesc@acq.osd.mil
Ruffner, Greg	Sundstrand	815-394-5697	gnruffner@snds.com
Soraya, Marvin	WPAFB/AFRL	937-255-4709, x4177	sorayamm@sensors.wpafb.af.mil
Tan, Dong	TRW	310-814-5250	dong.tan@trw.com
Trujillo, Ed	RSC	31--334-8461	etrujillo1@west.raytheon.com

Upon comparison of these architectures, it was apparent that the basic structure is the same for each of these industries; the differences become evident when the source power quality and voltages, and load power quality requirements are compared. More work is required to quantify these differences. RETURN



Response to EPSS NAECON'98 Meeting Action item #2 RETURN

Prepared by Sergio Navarro
8/10/98

Based on the 16 July Consortium Workshop, action was to categorize parameters as AC, DC, requirement, or design parameters.
Categorization was done in the following way: 1) Since EPSS is dealing with AC to DC or DC to DC power conversion, all load parameters can be considered as being DC parameters. 2) A source parameter can apply only to either DC or AC systems and in some cases a parameter can apply to both DC and AC systems; for the later the "Category" column is not annotated. If a parameter applies to either AC or DC systems, the "Category" column is annotated with either "ac" or "dc". 3) Requirement parameters are not highlighted in the tables below; they represent the explicit user requirements; design requirements are highlighted and they represent the implicit user requirements; implicit requirements represent unstated user expectations.

For us the question is:
What rules / building codes should we proposed to guide the development of power supply systems in order to accommodate the electrical interface requirements while maximizing the use of commercial resources.

It would be beneficial for each consortium member to think about this question and prepare to discuss and enlarge on answers during the Pre-INTELEC Consortium meeting (15, 16 September 1998 at Rockwell Collins, Cedar Rapids, IOWA)

As food for thoughts:
One potential approach is to base rules / building codes on: 1) the consortiums knowledge of "high end" commercial power supply product capabilities, 2) the electrical interface parameters, 3) the "new" COTS driven military electronic systems' requirements.

Load Requirement and Design Parameters – "What users specify" and "Implicit Design Needs"

LOAD ELECTRICAL Interface Parameter – All DC parameters	**Category**	**LOAD ELECTRICAL Interface Parameter– All DC parameters**	**Category**
Output Voltage and Tolerance	A	Power Failure Interrupt	B
Load Current Range	A	Over-temperature failure command to power supply	B
Voltage Ripple	A	Load Impedance	A
Voltage Programming	B	Status Monitoring	B
Overvoltage Protection Point	A	Power on Reset	B
Low Voltage Protection	A		
Overvoltage and Overcurrent characteristics	A	Output Impedance	A
Hold-up Time	A	Pin Current Capacity	
		(Pin outs)	
Start Up Trajectory – time domain	A	Overcurrent Trip point	A
Power Up Voltage Sequence, including Correct levels	A	Short Circuit Response	A
Shutdown Sequence	A	Current Sharing – multiple modules….pin definitions	B
Load Dynamics – step loads, etc.	A	Output voltage trim	B
Max di/dt	A	ESD	

Legend: A = Power, B=Other, Blank= Being Evaluated

Source Requirement and Design Parameters – "What users specify" and "Implicit Design Needs"

SOURCE ELECTRICAL Interface Parameter	**Category**	**SOURCE ELECTRICAL Interface Parameter**	**Category**
~~Output~~ SourceVoltage and Tolerance	A	Source Impedance as a function of frequency	
Source Voltage Ripple	A	Power Interrupt	
~~Load~~ Source Current Range	A	Reverse Polarity Protection	
Max Fault Current		Multiple Input Fault Tolerance	
Status Monitoring	B	ESD	
EMI			
Voltage Transients(spikes, sag, surge) characteristics			
~~Load~~ Source Dynamics – step transients, etc.	A		
Power Factor (1399-Navy, 1540, 704,….) • Harmonic content – loss of 1 phase(single phasing) • Third Harmonic Distortion • 3 phase: I & V balance • Frequency	ac	Spike / Surge Protection	
Isolation and grounding		*Input Impedance as a function of frequency*	
Inrush Current		Noise immunity – conducted susceptibility	
Voltage spike (<< than 1 cycle)		3 Phase – Phase rotation insensitivity	ac
Leakage current to ground	ac	Undervoltage Protection (shutdown & recovery characteristics)	
Source Max di/dt	A	Overcurrent Trip point	A

Legend: A = Power, B=Other, Blank= Being Evaluated
Note: Lack of "ac" or "dc" in category column indicates applicability to either AC or DC systems RETURN